

WHAT IS CLAIMED IS:

1. A method for investigating structural integrity, comprising:

providing a carrier member having a flexible surface, a plurality of electromechanical transducer elements being attached to said carrier member, said transducer elements being spaced from each other along at least two spatial dimensions;

conforming said flexible surface to a solid structural member, so that a substantial portion of said flexible member is in effective wave-transmitting engagement with said structural member;

after the conforming of said flexible surface to said structural member, transmitting pressure waves into said structural member;

receiving pressure waves reflected from an internal structural defect in said structural member in response to the pressure waves transmitted into said structural member; and

analyzing the received pressure waves so as to detect said structural defect.

2. The method defined in claim 1, further comprising:

generating a signal encoding an image of said structural defect from the analyzed pressure waves; and

presenting said image on a display.

3. The method defined in claim 2, further comprising operating a computer to highlight a selected feature of said structural defect on said display.

4. The method defined in claim 3 wherein the highlighting of said structural defect including varying video image intensity in a portion of a video image on said display.

5. The method defined in claim 2, further comprising operating a computer to select said image from among a multiplicity of possible images of said structural defect.

6. The method defined in claim 2, further comprising operating a filter stage to eliminate a selected artifact from said image.

7. The method defined in claim 1 wherein the analyzing of the received pressure waves includes operating a digital computer to derive a digital or electronic model of said structural defect.

8. The method defined in claim 7 wherein analyzing of the received pressure waves further includes operating said computer to perform an automated diagnosis or evaluation of said structural defect based in part on said digital or electronic model of said structural defect.

9. The method defined in claim 8 wherein the performance of said automated diagnosis or evaluation of said structural defect includes operating said computer to automatically compare said digital or electronic model with digital or electronic models of known structural defects stored in a memory of said computer.

10. The method defined in claim 1 wherein said carrier member includes a flexible web, said flexible surface being a surface of said web, the conforming of said flexible surface to said structural member including wrapping said web around at least a portion of said structural member.

11. The method defined in claim 10 wherein said transducer elements are mounted to said web, the conforming of said flexible surface to said structural member including placing said transducer elements in contact with said structural member.

12. The method defined in claim 1 wherein said carrier member includes at least one substantially rigid panel and a flexible web connected to said panel to form a bag along said panel, said flexible surface being a surface of said web, the conforming of said flexible surface to said structural member including placing said flexible web in contact with said structural member, the conforming of said flexible surface to said structural member further including feeding a fluid to said bag to press said web against said structural member.

13. The method defined in claim 12 wherein said transducer elements are mounted to said web, the conforming of said flexible surface to said structural member including placing said transducer elements in contact with said structural member.

14. The method defined in claim 12 wherein said panel is one of a plurality of panels, the conforming of said flexible surface to said structural member including placing said bag so that

said flexible surface faces said structural member and so that said panels are disposed on an outer side of said bag, away from said structural member, the conforming of said flexible surface to said structural member further including fastening said panels to one another about said structural member to limit expansion of said bag upon feeding of said fluid thereto.

15. The method defined in claim 12 wherein at least some of said transducer elements are disposed on said panel, said fluid being a liquid, the transmitting of said pressure waves into said structural member including transmitting said pressure waves through said liquid in said bag.

16. The method defined in claim 1 wherein the conforming of said flexible surface to said structural member includes placing said flexible surface in engagement with at least two surfaces of said structural member extending at a substantial angle relative to one another.

17. The method defined in claim 1 wherein the conforming of said flexible surface to said structural member includes fastening said carrier member to said structural member.

18. The method defined in claim 1 wherein the analyzing of the received pressure waves includes determining therefrom a three-dimensional shape of said structural defect.

19. The method defined in claim 1 wherein the transmitting of said pressure waves into said structural member includes producing said pressure waves in a plurality of different frequency ranges, the receiving of pressure waves reflected from said structural defect including

sensing pressure waves in said plurality of different frequency ranges.

20. The method defined in claim 1 wherein said transducer elements are mounted to said carrier member in a predetermined array, further comprising energizing said transducer elements in a predetermined sequence.

21. The method defined in claim 1 wherein the pressure waves transmitted into said structural member include ultrasonic frequency pressure waves.

22. An apparatus for investigating defects in structural members, comprising:  
a carrier member having a flexible surface, said carrier member including a pressurizable bag for conforming said flexible surface to a solid structural member, so that a substantial portion of said flexible member is in effective wave-transmitting engagement with said structural member;

a plurality of electromechanical transducer elements attached to said carrier member, said transducer elements being spaced from each other along at least two spatial dimensions;

a frequency generator operatively connected to at least a given one of said transducer elements for energizing said given one of said transducer elements to transmit pressure waves into said structural member; and

a frequency processor operatively connected to at least another one of said transducer elements to process pressure waves received by said another one of said transducer elements from an internal structural defect in said structural member in response to the pressure waves

transmitted from said given one of said transducer elements, said processor including means for analyzing the received pressure waves to detect said structural defect.

23. The apparatus defined in claim 22, further comprising an expansion restrictor surrounding said bag for limiting outward expansion thereof in a direction opposite said structural member.

24. The apparatus defined in claim 23 wherein said expansion restriction includes a plurality of rigid panels movably connected to one another and locks of fasteners operatively connected to said panels.

25. The apparatus defined in claim 22, further comprising imaging means for generating a signal encoding an image of said structural defect from the analyzed pressure waves, said imaging means being operatively connected to a display for presenting said image to a viewer or operator.

26. The apparatus defined in claim 22 wherein said processor includes means for deriving a digital or electronic model of said structural defect from the analyzed pressure waves.

27. The apparatus defined in claim 26 wherein said processor further includes means for executing an automated diagnosis or evaluation of said structural defect based in part on said digital or electronic model of said structural defect.

28. The apparatus defined in claim 22 wherein said transducer elements are mounted to said bag along a flexible panel thereof.